

DIMENSIONS

1 Kilometre per hour =
.62 miles per hr.

1 metre =
39.37 inches

1 Liter = 1.06 quarts

The Metric Changeover

38°Celsius =
100.4°Fahrenheit

1 Kilogram =
2.2 pounds

DIMENSIONS

NBS

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CONTENTS

- 123 More on the Metric Changeover
- 126 New Insights on the Causes of Fire Fatalities
- 128 Magnetohydrodynamics—An Old Idea With More Power to It
- 131 You, the Computer and Our Society in the Next Two Decades
- 132 Mobile Home Safety, Durability Studied
- 135 Highlights
- 136 Bone "Cement" Characterized
- 137 Major Appliance Manufacturers Support Energy Efficiency Program
- 138 Hydrogen Fuel Topics Published
- 138 Check Energy Labels on Room Air Conditioners
- 143 Publications

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Cover: How, when and if the United States will convert to the metric system of measurement are questions now facing the Congress. NBS Director Richard W. Roberts testified before the Subcommittee on Science, Research and Technology on the Administration's bill on voluntary metric conversion. Excerpts from his testimony can be found on page 123.

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The Institute for Materials Research
The Institute for Applied Technology
The Institute for Computer Sciences and Technology

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Center for Building Technology
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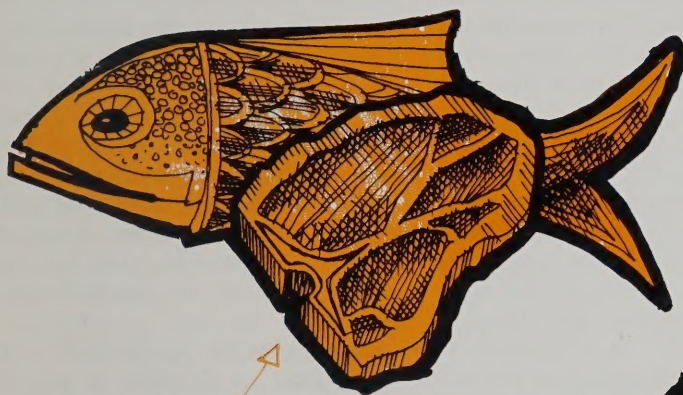
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1 Degree Celsius *difference*
1.8 Degrees *difference*
Fahrenheit →



1 Gallon =
3.8 Liters →



1 Hectogram = 3.5 Ounces



55 Miles Per
Hour = 89 Kilometres
Per Hour

More on the Metric Changeover

On April 29, 1975, Dr. Richard W. Roberts, Director of the National Bureau of Standards testified before the Subcommittee on Science, Research and Technology of the House Committee on Science and Technology on conversion of the U.S. system of weights and measures to the metric system. Excerpts from Dr. Roberts' testimony follow.

It is clear that the United States is going metric. Many of our largest manufacturing companies — giants such as IBM, Rockwell-International, and General Motors—are changing over. As the large firms convert to metric usage, so must thousands of their smaller suppliers. And as more and more metric products ap-
turn page

METRIC *continued*

pear in the marketplace, every consumer must become familiar with metric measurements. In response, almost every state is now teaching metric, or planning to do so in the near future. Many Federal agencies are using metric units, and others are ready to go metric. Metric bills have been introduced in 13 states, and enacted in Massachusetts and Minnesota, to guide the metrication process.

Haphazard or Coordinated?

Does this tide of metric conversion mean that the process can go on unaided? Far from it. As metric usage increases so does the need for education and coordination on a national scale. The relatively smooth transition taking place in many industries could become very rough if major segments of industry or society end up on opposite sides of the metric fence.

The metric system, based as it is on decimal relationships, is inherently simpler to use than our customary units of measurement. Experience

shows that when people become familiar with the metric system they tend to favor its adoption. Since growth of metric use is accelerating, there is great need to inform all Americans about the metric system and its advantages. This is one of the major tasks facing us in the years ahead.

The major advantage of going metric is economic. Over the long run, greater returns from increased efficiencies will far outweigh conversion costs. Our ability to compete in metric foreign markets and the efficiency of production for American consumers will be improved by metrication. Manufacturers, retailers and exporters are converting when it is cost effective to do so. That classically simple rule should continue to guide us in the future.

I suggest that we, as a highly industrial nation competing in a metric world marketplace, must continue our swing to metric usage. The question then is not *whether*, but rather *how* metric usage will evolve.

There seem to be two broad avenues open. The metrication process can be left to uncoordinated, haphazard development. Or, the Federal Government can provide national leadership in coordinating conversion to metric usage. If the path of no coordination is selected and there is no national policy decision by the Congress, we will continue to drift, with each organization making its metric decision largely independently. By 1980, whole industries such as automobiles and business equipment will be predominantly metric.

The alternative avenue that I see open is for the Congress to provide an officially stated national policy on metric use. A coordinated approach could take various forms in the specifics of its development.

—Conversion could be either voluntary or mandatory.

—The transition could be over a fixed time period or open ended.

—Federal subsidies for conversion costs could be either provided or not provided.

These differences are reflected in the provisions of the five metric conversion bills now before the Congress. These bills are, for the most part, quite similar. However, let me say why, on a feature-by-feature basis, I advocate H.R. 6154.

Each of the bills declares a national policy of converting to metric and establishes a Board or Commission to coordinate conversion. The Metric Board established under the Administration's proposal, H.R. 6154, would have two functions. The first is to provide a national forum where interested parties could convene to discuss changeover problems and develop coordinated approaches to

NBS Director Roberts and California's Rep. James Lloyd watch Rep. James Symington of Missouri ride a "metric" exercise bike during a break in testimony on proposed metric legislation.



metric changeover. The Board will also ensure that the whole populace is informed about why the Nation is going through this effort, about the metric units needed for everyday life and about current and expected changeover developments.

A key focus of both of these activities is the interest of consumers. In the measurement language change that is upon us, there will develop possibilities of consumer confusion. Industry can to a large extent solve its own metrication problems—a significant segment of industry is now demonstrating this by proceeding with conversion. Our educational system, at the state as well as the Federal level, is beginning to develop its needed responses to growing metric use. For the consumer to receive the potential benefits of simplified measurements and improved sizing of products and packages, with least cost and disruption of marketing patterns, there must be a nationally established body incorporating the consumer viewpoint.

To do its job well, the Board needs to be representative of the widely varied spectrum of our society—education, government, consumers and industry. This is why we feel a Board of 25 members is needed, rather than the 11 that would be provided by H.R. 492 or H.R. 627.

Finally, taking cognizance of the existence of the American National Metric Council, the Administration's bill states that "The Board will take advantage of activities underway in the private sector so as not to establish, within its own organization and staff, provisions for activities that would unnecessarily duplicate those being undertaken in the private sector."

Some of the bills specify an overall conversion plan with a transition time of 10 years. I see advantages in letting the Board develop plans and set timescales suitable to individual sectors. On both these points, H.R. 6154 is in agreement with the Labor bill, H.R. 6177.

While H.R. 627 provides that metric would be the sole system in 10 years, I favor the voluntary approach of the other bills, including H.R. 6154. The "rule of reason" should prevail here; conversion in a particular area should take place only if it is practical and makes economic sense.

The Subsidy Question

A further alternative within the general approach of a coordinated national effort concerns the matter of whether or not the process should be assisted with subsidies. If special Federal subsidy or financial assistance is provided, as called for in H.R. 6177, many unnecessary tool and machinery replacements may be made in the name of metric conversion. A question will be raised: What to do about subsidies for the many companies and organizations that have already made substantial changeover moves? A staff of some size would be required to evaluate subsidy applications and administer payments. Inescapably, U.S. changeover to metric would be measurably more costly with the availability of subsidies.

With a voluntary approach, such as I described a moment ago in which no one should decide to go metric unless it is in the economic interest of the person or organization making them, subsidies are clearly unjustified.

It has been argued that some types of workers need the protection of

subsidies for their replacement of tools and their learning metric, if and when their employing company switches to using metric measures. I believe a sufficient answer to this contention is to cite the experience of General Motors Corporation—the United States' largest employer of workers in measurement-sensitive trades. GM has been designing all new parts for its vehicles in metric since January 1973, and is now assembling 1975 automobiles with some metric parts. The matters of replacement of worker-owned tools and of employee retraining have been taken care of in GM's labor contracts, and I understand that the corporation has had no problems with these matters.

I have explained why we feel strongly that subsidies should not be provided in the basic legislation establishing our national conversion effort. As metric changeover progresses, valid needs may arise requiring financial relief in specific areas. H.R. 6154 provides for these needs, stating that the Board shall conduct research, publish the results of this research, and when appropriate recommend corrective action—perhaps even new legislation.

Unless we could go metric overnight, which is impossible, there must be a period of dual units and dual inventories. This is not the real hurdle it might seem at first glance. It is preferable to label or "dimension" drawings in one system for reasons of accuracy and cost. Where necessary, dual dimensioning can be handled by computer.

There is also the question of dual inventories as we go metric. Again, this problem presents more of an opportunity than a challenge. While

continued on page 139

New Insights on the Causes of Fire Fatalities

THREE people died in residential fires recently, but none was burned by flames. A child who accidentally set a fire with matches ran and hid instead of alerting an adult. A woman tried to get dressed instead of immediately escaping in her sleepwear. A man fell asleep after several drinks and forgot about his cigarette. All three died from toxic fumes before anyone could help.

In most fire fatalities, fire officials and doctors know little about why the victim died, whether he received any warning, and why he did not or could not escape. To date, the medical profession has not explained exactly how a fire's toxic fumes kill people; no one knows why people often act irrationally in a fire. However, under an ongoing study funded by the National Bureau of Standards,

fire deaths like these are being examined from every angle. The study already offers new insights into the causes of fire deaths which do not involve burns, and promises to offer more.

Organized by the Johns Hopkins University Applied Physics Laboratory (JHU/APL) in Howard County, Md., the study combines the efforts of medical experts, scientists, and



state and local fire officials. It is being carried out in conjunction with NBS-funded experiments at the University of Pittsburgh, the University of Utah, and at Johns Hopkins University.

Analyzing Fire Fatalities

All Maryland fire victims who die from toxic fumes and who are subsequently autopsied are included in the study. Detailed autopsy results are reported by the state medical examiner. Investigators from JHU/APL meet with state and local fire officials to take samples of soot and materials from the scene of the fire. NBS, the Johns Hopkins School of Hygiene and Public Health, the state medical examiner, state and local fire marshals and investigators, and JHU/APL scientists all participate in gathering and analyzing data in order to learn as much as possible about the fire and the victim's death.

By combining and studying medical, biochemical, toxicological and other data, scientists are developing a better understanding of why people die in fires. From 82 fatalities studied in 1974 and others in previous years, systems analyst Byron Halpin of JHU/APL has reached a number of conclusions. His data clearly reveal a "prevalence of human carelessness" in causing fires that kill.

"By far the largest cause of fatal fires in the study is smoking," Halpin said. While smoking is not the largest cause of all fires, it caused 55 out of the 105 fatal fires that occurred in Maryland from September 1971 through January 1974.

Even more dangerous than smoking is the combination of smoking and drinking. "There was a prevalence of alcohol in the data—67 percent of the fatal fires caused by smoking also

involved use of alcohol," Halpin said.

"Smoking and drinking are a bad combination—a combination that causes people to do foolish things," Halpin remarked. "It's a very serious problem in the ignition phase of a fire; people forget about cigarettes they've already lit. And once they become intoxicated, they don't react to warning signals properly."

Halpin noted that the alcohol problem has increased recently. "Before 1974, 30 percent of all fire fatalities in the study involved alcohol. But in 1974, that figure increased to 56 percent—a significant increase," said Halpin. "The trend in 1975 seems to be continuing at this high level."

What sort of people are causing these fatal fires? Contrary to some popular notions, they are not careless teenagers or housewives "The primary culprit with alcohol and smoking is the white male over 40," said Halpin. "Since he causes the fire and usually dies in it too, he is both the victim and the culprit."

Halpin pointed out that 0.1 percent of alcohol in the blood is the legal level of intoxication in most states. "We found more than 0.15 percent in many autopsies," Halpin said.

Out of 36 fire fatalities involving both smoking and heavy drinking—more than 0.15 percent blood alcohol level, 28 of the victims were male, and 22 of those 28 were white. Only 8 out of 36 victims were female, and only one of the 8 females was black.

Reactions to Fire

Smoking and drinking aren't the only foolish human behaviors that result in fire and death. Irrational behavior in the face of a fire, for reasons not yet understood, also contributes

to the problem. Many fire victims look for a difficult exit when a safe and simple one is nearby. "Children tend to run and hide," noted Halpin. "Is this because they are afraid of the fire or of being punished by their parents?"

"Adults will also go back to try to save a child or another adult when it's clear that there's no chance to survive," Halpin continued. "Or they will go back into a burning house to retrieve an object or a pet."

"Vanity, too, is a factor that keeps people inside a burning house too long," Halpin said. "In one recent case, two men had a fire in their apartment. The one that escaped in his shorts survived. His roommate tried to put on a pair of pants before leaving and died of carbon monoxide poisoning. Even the time it takes to put a pair of pants is crucial in a fire situation."

Different ways of reacting to fire can mean life or death, the study shows. This is one of the primary reasons why children under ten and persons over 40 are most often the victims of fatal fires. "Children sleep

continued on page 142



Magnetohydrodynamics

An Old Idea With More Power to It

EARLIER this month, several hundred scientists and engineers from around the world converged on the State Department in Washington, D.C., for a week-long conference on a little publicized field of power generation. The object of their attention was magnetohydrodynamics, or MHD, a means of generating electricity from fossil and nuclear fuels, especially coal, that promises to be more efficient and less polluting than conventional forms of electric power generation.

The conference was the sixth in a series of such meetings started in the early 1960's when research in the field had reached a stage where inter-

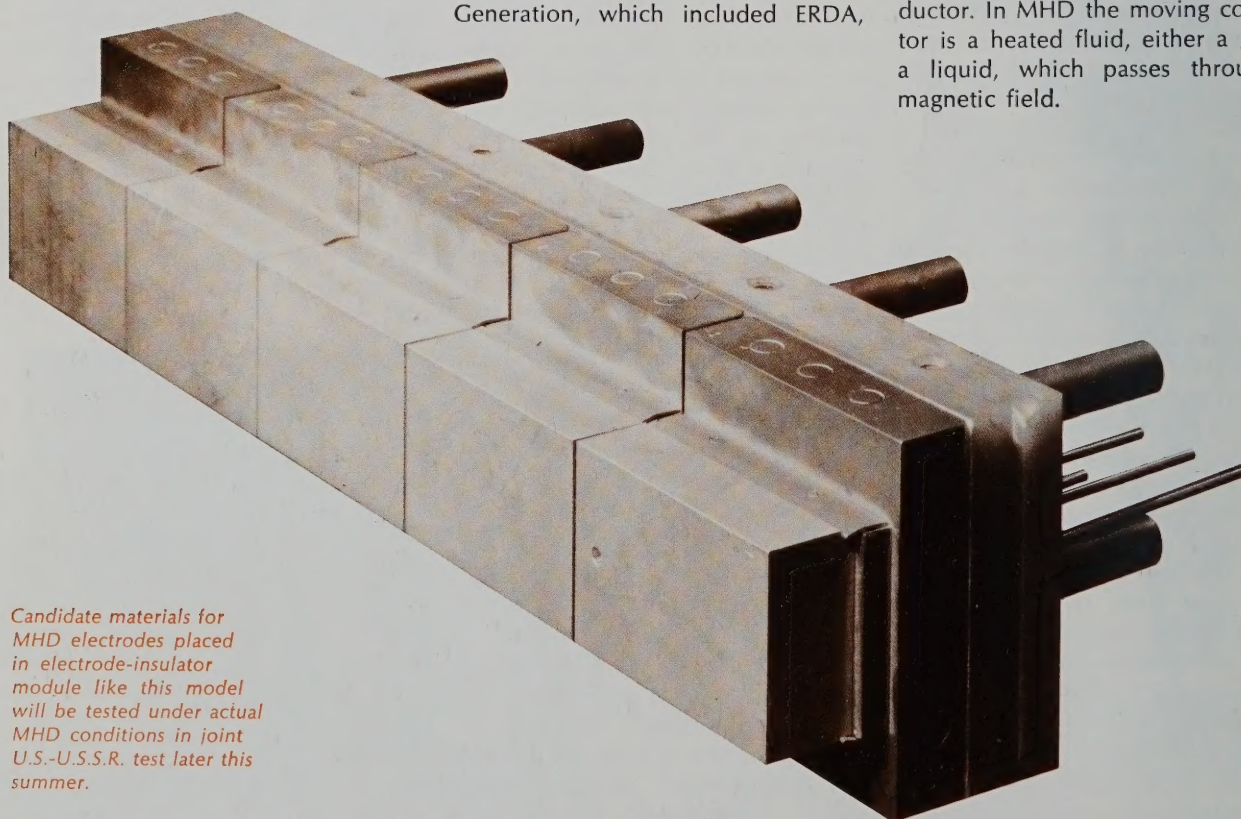
national cooperation could help speed development of MHD generating plants. The culmination of this cooperation is a joint United States-U.S.S.R. test scheduled later this summer in Moscow designed to see how well various components of an MHD system stand up under rigorous conditions. Planning for the test, sponsored on the U.S. side by the Energy Research and Development Administration (ERDA), has involved U.S. scientists from ERDA, the National Bureau of Standards, the Massachusetts Institute of Technology, Battelle Northwest and Westinghouse Corp.

The widely based, international interest in MHD is also reflected by the sponsors of the Sixth International Conference on MHD Electrical Power Generation, which included ERDA,

NBS, the U.S. Office of Naval Research, the Electric Power Research Institute and the Symposia for the Engineering Aspects of Magnetohydrodynamics, Inc. Also cooperating were the International Atomic Energy Agency and the Nuclear Energy Agency of the Organization for Economic Cooperation and Development.

Old Concept

MHD itself is not a new concept; in fact, Michael Faraday established the physical basis for the process in the early 1800's. Simply stated, when a material that conducts electricity is passed through a magnetic field, voltage is induced. In a conventional electric generator the magnetic field surrounds a rotating metallic conductor. In MHD the moving conductor is a heated fluid, either a gas or a liquid, which passes through a magnetic field.



Candidate materials for MHD electrodes placed in electrode-insulator module like this model will be tested under actual MHD conditions in joint U.S.-U.S.S.R. test later this summer.

In its simplest and most widely developed form—open-cycle MHD—a fossil fuel such as natural gas, petroleum or, most importantly, coal is burned in a combustion chamber with preheated and/or oxygen enriched compressed air to produce temperatures in the range of 2500 to 3000 K. The combustion products of these fossil fuels are "seeded" with an easily ionized element, such as potassium or cesium, to increase the electrical conductivity of the hot gases. The expanding hot gases propel themselves through a channel which is situated between the poles of a magnet. By placing electrodes on the channel wall, perpendicular to both the fluid stream and the magnetic field, direct electric current is obtained at relatively high voltages. The electrodes are analogous to the brushes of a conventional generator as they transfer electrical energy to the external circuit. The direct current is then usually converted from direct to alternating current.

MHD is so attractive because thermal energy in a gas or liquid is converted directly into electric power—without the need for a turbine or rotating generator. The lack of moving parts in contact with the hot working gas simplifies the system and permits higher temperatures to be used, which in combined cycles (MHD and steam plant) means greater efficiencies. It is estimated that MHD combined cycles would have a conversion efficiency (thermal to electric) of 50 to 60 percent compared to 40 percent for conventional electric generating steam plants and 32 percent for nuclear plants.

In addition to all these advantages, MHD has environmental advantages as well. Coal containing high amounts

of sulfur, which currently cannot be burned in the United States because of environmental restrictions, can be used in MHD plants. This is because sulfur in the coal reacts with the alkali seed particles to form sulfate compounds which precipitate out and can be recovered from the exhaust gases. Nitrogen oxide emissions can also be reduced if the coal is burned in a fuel-rich mixture (which is preferred for MHD operation) with excess air for complete combustion added further downstream in the system.

Materials Problems

Its inherent simplicity makes MHD ideal for large-scale facilities producing power—at least 100 megawatts and up. Yet the closest to such a facility is a pilot plant with a potential power of 25 megawatts built in the Soviet Union 4 years ago, called the U-25. To date, at least a dozen countries have research programs aimed at reaching the ultimate goal of commercial MHD power generation. For example, the Russians recently produced 12.5 megawatts for a half hour for the first time in their U-25. In the United States ERDA sponsors programs at a variety of organizations including NBS, the Arnold Engineering Development Center, the University of Tennessee, Westinghouse, MIT, Avco Corporation and others.

However, many problems must be solved before MHD becomes a commercial source of electricity. The problems include the need for extremely strong superconducting magnets, around 5 teslas (50,000 gauss), because the gases have a lower conductivity than the conductors in conventional generators; difficulties in achieving high pressure and high

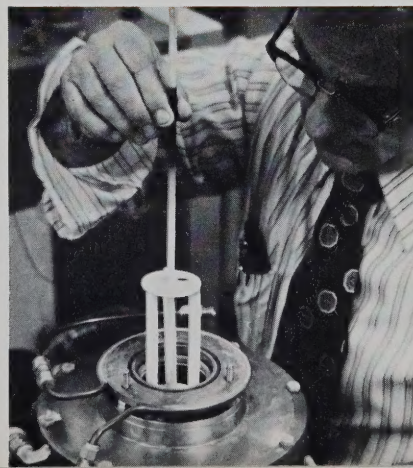
temperature combustion of coal; and coal ash corrosion of the generator walls or of the air heater.

The materials problems in MHD systems, as with all high temperature conversion techniques, are probably the greatest obstacles today to its practical use. The combination of seed material and high temperatures produces an extremely hostile environment. The combustion chamber, channel, electrodes, insulating material and related parts must be able to withstand thermal shock and to resist corrosion through oxidation, erosion and alkali attack. Still unanswered are a number of questions concerning the selection and behavior of materials for such an environment. This is due in part to a shortage of reliable physical and chemical data and the lack of engineering experiences with materials under MHD conditions.

Seeking solutions to MHD materials problems are a number of groups in the United States, in particular the ERDA MHD Project Office headed by William Jackson. The MHD Project Office is under the supervision of the

turn page

NBS physicist William Hosler loads samples in furnace to measure high-temperature electrical conductivity of materials potentially useful in MHD generating systems.



MHD continued

ERDA Assistant Administrator for Fossil Energy (formerly the Office of Coal Research of the Department of Interior), which funds the bulk of MHD research. Studies carried out at the National Bureau of Standards under ERDA sponsorship are aimed at providing endurance and property data on MHD materials, obtaining criteria for MHD system design and assisting in developing specifications and test methods for containment materials. The Bureau's MHD program involves about a dozen scientists and engineers from various disciplines and is headed by Sam Schneider, Hans Frederikse and Taki Negas of the Institute for Materials Research.

In their early studies, the NBS scientists concentrated on defining the behavior characteristics of materials that may be used in MHD and in characterizing the coal slag flowing through the system. Coal slag results from the inorganic material always contained in coal. When coal is burned, these materials condense and produce a thin layer (slag) on MHD components. This layer may be partly liquid or solid; it is of special interest to scientists because it is thought to have beneficial as well as detrimental effects. For instance, it is thought that the slag may chemically tie up a large portion of the alkali seed, which would lead to reduced seed recovery and poorer performance characteristics — detrimental effects. On the other hand, the slag may protect the walls of the MHD components from erosion and chemical attack (corrosion) and still permit the passage of current to the electrodes.

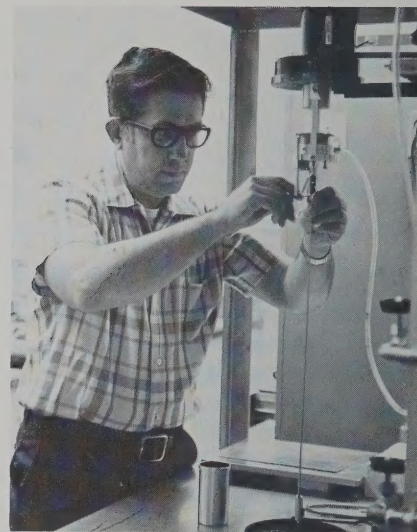
The NBS group has analyzed coal slag specimens from MHD facilities using a variety of techniques—chemi-

cal analysis, microscopic examinations, x-ray diffraction, differential and gravimetric thermal analysis and Mossbauer spectroscopy. From these studies they learned that the chemical and phase (mineral) content of the coal slag varies according to the location in the MHD system from which the slag was sampled as well as the original source of the coal. The varying mineral content, of course, affects the way in which coal slag reacts with seed particles and other materials parts of the MHD system. All slags, they found, were composed largely of mixtures of oxides of aluminum, iron and silicon.

Model Slags

With this knowledge in hand, the NBS team decided that it was impractical to try to measure the various properties of slag from each and every coal source. Instead, they began preparing a systematically varying series of simple synthetic, or "model," slags. Using these synthetic slags, the NBS group has begun studying the variations of electrical conductivity and viscosity with changes in temperature and composition and the interactions of slag with other materials used in MHD systems. Initial studies have resulted in the development of equations with which the viscosity can be calculated for any composition and temperature within the prescribed limits. Additional research is expected to result in extending the equations to predict coal slag viscosity for systems with more components.

Other studies at NBS are aimed at determining the complex reactions and phase equilibria of seed material with coal slags, insulator materials and electrodes, as well as the inter-



NBS technician Dale Kauffman adjusts viscometer in preparation for high-temperature viscosity studies of synthetic coal slags similar to those found in MHD systems.

actions of coal slag with electrode materials insulators and air preheaters materials. The problem in studying the latter is that the final choices of materials for these three groups of MHD components have not yet been made, and, in fact, information gained about these reactions may well influence which materials are ultimately selected.

To gain more information in this area, NBS, the University of Tennessee Space Institute (UTSI), Westinghouse Corp., Avco and others are cooperating in a program to test materials proposed for MHD. As materials and slags are tested in various MHD systems, they are sent to NBS and examined by different means, such as x-ray diffraction and scanning electron microscopy. Recent samples of lanthanum chromite, silicon carbide and zirconium diboride—potential materials for electrodes and insulators—were tested in the UTSI channel, once using a clean fuel and once using coal as the source of fuel. In the test with coal, NBS and UTSI scientists determined that a 1 to 2 millimetre slag layer was formed which lowered the electrode tem-

continued on page 139

You, the Computer and Our Society

in the Next Two Decades

In the future, automation technology may be used in remotely controlled undersea oil drilling.



by Ruth M. Davis*

PEOPLE and computers will exist for the next 20 years. Further, computers and man will exist together within some benevolent structure, friendly to both, which will be a society of sorts. Everything that follows depends on a belief in these assumptions, because there is no

proof for them that holds in the future.

Indeed, one of the most apparent shortcomings of human intellect is in predicting and preparing for the future. Therefore, looking at a very new technology — computer technology, looking at people who pride themselves at being unpredictable and guessing what the next 20 years will bring is an exercise worthy

of all the skill, imagination and foresight we can muster.

I firmly believe that the best technique we possess for taking a realistic peek into the near future is that of science fiction modified by foreseeable man-made constraints such as individual concerns, institutional barriers, national priorities and budget realities. These constraints slow down the attainment of the idealized science fiction scenarios which seem so much better than the real world of today. Employing science fiction allows the freedom of unfettered scientific imagination to reign, with science playing center stage.

Moreover, once we have cultivated our scientific imaginations and then qualified them with near-term realities, we will probably have done a fair job of technological forecasting. Using this approach will hopefully prevent one of the most common injustices we practice on computers and computer science; namely, treating their future in terms of incremental changes to their past.

What is desperately needed today is the ability to see a better tomorrow and to see how to get from today to that tomorrow. In addition to imagination, this task takes structure. The best structure we can introduce is one that highlights both the scientific ideas and the societal realities that will take us from today to the tomorrow for which we are aiming.

In dealing with computers, individuals and society, I suggest that we consider the world of tomorrow in terms of:

Man WITHOUT computer,
Man WITH computer,
Computer WITH man,
Computer WITHOUT man, and

continued on page 140

*Dr. Davis is the director of the Institute for Computer Sciences and Technology at the National Bureau of Standards.



Mobile Home Safety, Durability Studied

MOBILE homes were once considered "second class citizens" in the housing industry. They were truly mobile—transported by car or pickup truck from location to location. They were often set down in unsightly trailer parks on the edge of an industrial sector or beside a heavily traveled secondary highway. Persons who resided in mobile homes were frequently regarded as nomads who moved from job to job and city to city. Or so their house-bound neighbors thought.

Much of this has changed within the last decade. Campers and other recreation vehicles have come onto the market for persons desiring to be genuinely mobile. And mobile homes have moved into the ranks of respectability in the housing industry. Production of mobile homes increased from 103,000 in 1960 to 567,000 in 1973. (Production fell to 371,000 in the 1974 depressed housing market.) In the last 5 years mobile homes have supplied about 30 percent of the single-family housing units in the United States. In 1973 mobile homes represented 91 percent of all new single-family housing selling for less than \$20,000.

Mobile homes are no longer truly mobile. They are generally hauled to the housing site by tractor-trailers and most are never moved again. The most popular singlewide mobile homes sold today are 3.60 metres (12 feet) or 4.2 metres (14 feet) wide and vary in length to 24 metres (80 feet). Doublewide units, formed by the adjacent siting of specially designed singlewide mobile homes, compare quite favorably with a conventional house for living space.

Changes in attitudes—and local

zoning laws—have also enabled mobile homes to be located in comfortable residential surroundings. With metal "skirts" covering the space between ground and the bottom of the home, a well-situated mobile home today is almost indistinguishable from a conventional house. Because of the relatively low price (1973 averages—\$6,900 for singlewide and \$11,300 for doublewide), the mobile home has become an attractive home buy in a period of high inflation in the housing market.

Along with the boom in mobile homes has come concern for their safety and durability. Wind and fire damage have been two problems to receive widespread publicity. Quality of construction has been another concern. The industry, voluntary standards organizations and government have responded to these concerns. Manufacturers have improved their quality-control procedures; the American National Standards Institute has upgraded its A119.1 Standard that governs all aspects of mobile home construction including plumbing, heating and electrical wiring; and the Congress in 1974 gave the Department of Housing and Urban Development the responsibility for developing a uniform mobile home standard and enforcement process.

Within the last several years the National Bureau of Standards has become active in supporting these efforts to make mobile homes even more attractive for the home buyer. NBS currently has seven projects underway in this area. While many of them are in support of HUD's mandate to produce a mobile home standard, NBS is also examining

turn page



Researchers at the NBS Center for Fire Research simulate a grease fire to study fire problems inside mobile homes.

HOMES *continued*

mobile homes for potential fire hazards in cooperation with the Mobile Home Manufacturers Association and HUD, is working with the ANSI committee developing the A119.1 Standard and is studying energy conservation measures for mobile homes for the Federal Energy Administration.

In a major undertaking for HUD, the Bureau is carrying out a mobile home problem identification and analysis project. This involves identifying and documenting significant mobile home performance problems and determining the relationship, if any, between the problems and ANSI Standard A119.1, mobile home enforcement process, longevity and durability of components.

This project, begun in March 1974, is nearing conclusion. It has involved the analysis of 3,848 files on mobile homes and the field inspection of 257 mobile homes. Much of the data came from mobile homes purchased by HUD to aid Pennsylvania victims

of Hurricane Agnes in June 1972. Some 32,000 pieces of problem data were generated from these studies. These data are being analyzed and a final report is being completed.

James H. Pielert, NBS project leader, said some of the problems encountered included rain leaks, unsatisfactory performance of the underside construction of mobile homes, failure of the metal frame support system, buckling of interior paneling and loose plumbing and electrical wiring. The results of the NBS research will be used by HUD in the development of its own mobile home standard, which is expected to draw heavily on ANSI A119.1.

Pielert noted that, beginning in 1969, the ANSI standard was upgraded to include such life-safety items as smoke detectors, pushout egress windows for bedrooms and tie-down straps for protection against high winds. NBS is represented on ANSI A119 Committee on Mobile Homes and Recreational Vehicles

and has supported the upgrading. One measure of success is the fact that 46 states now require mobile homes to be constructed to A119.1 or variations thereof.

Working for the Federal Energy Administration, NBS has been conducting infiltration and air leakage tests on mobile homes as part of a project to retrofit housing units to conserve energy. Much of the testing has been conducted in the Center for Building Technology's environmental chamber on a 1974 model mobile home where extremes of summer and winter temperatures are simulated.

NBS' mobile home fire safety program is being conducted by the Center for Fire Research where scientists and engineers hope to obtain data on the potential growth and spread of fire in mobile homes as affected by interior finish, geometry and location of ignition. Other objectives are to develop design criteria for controlling the principal factors which may contribute to rapid and extensive fire growth and production of smoke and noxious gases. Criteria for the performance of smoke and heat detectors in mobile homes will also be developed. Four mobile homes, three obtained from HUD and one purchased new, will be used for a comprehensive series of full scale and laboratory tests.

Other mobile-home related projects include advising HUD on the most cost-effective way of storing mobile homes, preparing a resource document for the application of the performance concept to mobile home standards and preparing a report that summarizes the extent to which states have chosen to amend the existing ANSI standard for mobile homes. □

Slightly warped roof of mobile home in foreground illustrates roof-leakage problem in these Government-owned homes being stored in Pennsylvania.



HIGHLIGHTS

Environmental Standards

More than 40 Standard Reference Materials (SRM's) useful for environmental research and control are available from NBS. In addition to analyzed gases of various concentrations, individually calibrated permeation tubes, analyzed liquids and solid materials certified for trace elements including a number of toxic and hazardous elements, are available.

These SRM's are described in a new NBS pamphlet that may be obtained from the Office of Standard Reference Materials, B311 Chemistry Building, NBS, Washington, D.C. 20234.

Portable X-ray Devices

A performance standard for portable X-ray devices used by bomb squad technicians in bomb disarmament was recently developed by NBS for the National Institute of Law Enforcement and Criminal Justice. Performance requirements for these devices include such properties as image quality, ruggedness, portability, set-up time and ability to function properly under extremes of temperature, humidity and electric power. The safety requirements called for in the standard are aimed at minimizing the radiation hazard.

Noise-Con 75

A program with a wide appeal to those in industry and government concerned with noise control has been announced for NOISE-CON 75, the 1975 National Conference on Noise Control Engineering, to be held September 15-17, 1975 at NBS' Gaithersburg, Md.; laboratories. Co-sponsors of the meeting are the Institute of Noise Control Engineering and NBS.

Sessions of the conference will focus on important areas of noise control engineering, the regulatory and research activities of government agencies concerned with noise and the work of technical societies concerned with noise control in various engineering disciplines.

For information write the Institute of Noise Control Engineering, P.O. Box 3206, Arlington Branch, Poughkeepsie, N.Y. 12603. Telephone: 914/462-6719.

Weather Service Network

NBS has made recommendations for network topology and computer system specifications to the National Weather Service for its Automation of Field Operations and Services Network. Scheduled to be implemented in phases over the next 5 years, the network will interconnect about 50 weather service forecast offices, 200 weather services offices and several specialized centers.

NBS reviewed plans for the computer-communications network, analyzed its capacity under various operating conditions, evaluated reliability factors and devised alternate recovery plans for minimizing service disruption.

Lead in Reference Fuel

Three Standard Reference Materials (SRM's) for use in the determination of lead in motor fuel have been issued by NBS. They consist of blends of leaded reference fuel with nominal lead concentrations of 0.03, 0.05, 0.07 and 2.0 grams per gallon (12, 20, 28 and 773 $\mu\text{g/g}$).

These new SRM's will allow producers, consumers and regulatory agencies to refer their measurements of lead in motor fuel to a common

agreed-on basis. Information on SRM's can be obtained from the Office of Standard Reference Materials, B311 Chemistry Building, NBS, Washington, D.C. 20234.

Triple-Point Vapor Pressure of Water

The vapor pressure of water at its triple point has been redetermined by NBS scientists. The new value is 611.665 (± 0.009) Pa, compared to the value of 611.2 Pa found in most standard references. In this work the water vapor pressure was balanced across a sensitive diaphragm by a pressure of helium gas that was measured by the NBS precision mercury manometer.

Because thermodynamic temperatures are defined by assigning the value 273.16 K to the triple point of water, an accurate value of the vapor pressure of water at the triple point is needed in the development of PVT and thermodynamic tables, which are applied in steam power technology, humidity measurements, meteorology and in thermodynamic calculations involving properties of vapor.

NBS Annual Report

NBS recently announced the publication of its Annual Report for Fiscal Year 1974. The report presents an overview of NBS program goals, both past and present, with special emphasis on projects underway during FY74. In addition, the report includes sections on budget and facilities, people and organization.

The report may be ordered as SD Catalog No. C13.10:418 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for \$1.00. □

Bone "Cement" Characterized



THE properties of a bone "cement" have now been described to help improve the chances for success in the many thousands of hip joint replacement operations performed each year by orthopedic surgeons.

Chemist Dr. Gerhard Brauer and physicist George Dickson of the National Bureau of Standards' Dental and Medical Materials Section, working with Dr. Stephen Haas of the George Washington University Medical Center, Washington, D.C., investigated poly(methyl methacrylate) cement in laboratory tests simulating hip joint replacement operations. Their findings are now available to surgeons who replace diseased or damaged hip joints with prosthetic devices (artificial parts).

NBS studies of the characteristics of the cement used to stabilize these devices in place will help surgeons better control the surgery and assure permanent replacement of bones and joints that have failed. The resulting information has been used to develop American Society for Testing and Materials voluntary consensus standards for both orthopedic and neurosurgical applications.

The NBS researchers have published in the April 1975 issue of the *Journal of Bone Joint Surgery* their characterization of the chemical, physical and mechanical properties of the material as it polymerizes during the operation. The surgeon can use this characterization to allow

for the variables of environment, temperature and handling techniques as he mixes and uses the cement in the operating room.

A surgeon "makes" the cement by mixing a premeasured vial of liquid monomer and a premeasured packet of powdered poly (methyl methacrylate) to get a doughy mass. He kneads the mass, packs this dough into a prepared bone and then inserts a metal prosthesis to replace the damaged end of the bone which has been removed. A plastic cup is similarly attached to the reamed-out socket in the pelvis and the new joint is complete.

The cement forms a mechanical attachment to steady and cushion the artificial parts.

The NBS scientists determined the dough time (the time from the initial contact of the powder and liquid until the cement no longer adheres to a surgically gloved hand); setting time (the time from mixing to attaining peak temperature); and handling time (the period when the material progresses through the workable to the hardened stage).

They found that the time for the material to reach the dough stage is greatly affected by the temperature of the operating room in which it is mixed. Specifically, they report that increasing the temperature shortened the dough time, the setting time and the handling time, but had no significant effect on the peak temperature of polymerization.

When the powder to liquid ratio was varied from 2:1 to 3:1, the dough time, setting time and handling time as well as the peak temperature of polymerization were reduced. Increased kneading reduced the setting and handling times, and raised the

peak temperature slightly. Increasing the humidity caused only a slight decrease in dough time, setting time and handling time.

Aging of the components of the cement for up to 5 months at room temperature in their sealed packages had no effect on the performance of the cement.

The scientists also report that although the cement "hardens" in about 10 minutes, it has not reached its full strength in that time. They advise the surgeon to avoid undue pressure on the prosthesis following this period since such force may loosen the device.

The present investigation is limited to a characterization of the material. However, in their attempt to improve the safety and reliability of the cement, the scientists have also defined some factors which may be potential causes for its malfunctioning.

For example, the high temperature created when the cement polymerizes may be harmful to the bone layer near the cement. Some shrinkage of the cement takes place during setting, but this does not appear to have a major effect on the use of the material. Another possible problem is the escape into the tissues of small amounts of monomer which remain in the cement after the initial hardening.

The use of poly(methyl methacrylate) bone cement in orthopedic surgery is a recent development, but the material has been used widely in other fields since the 1930's. Most notable is its use as the denture base for false teeth. Other diverse non-biological uses include outdoor signs, plastic furniture and automobile windshields. □

Major Appliance Manufacturers Support Energy Efficiency Program

SECRETARY of Commerce Rogers C. B. Morton recently announced that 33 major appliance manufacturers have expressed their intention to work toward the voluntary energy efficiency goals for appliances set by President Ford as part of his national energy conservation plan.

The goal, a 20 percent average reduction in the amount of energy used by new major appliances by 1980, was established by President Ford in a supplement to his State of the Union message on January 15. President Ford noted at that time a 20 percent reduction in energy usage would save the equivalent of over one half million barrels of oil per day by 1985.

Secretary Morton released the names of 33 companies supporting these goals at the conclusion of 2 weeks of meetings with appliance manufacturer representatives. The meetings were held at the Department of Commerce's National Bureau of Standards, which is supplying technical support for the new Voluntary Program for Appliance Efficiency.

These companies represent all categories of appliances for which energy efficiency goals are being set: room air conditioners, refrigerators, combination refrigerator - freezers, freezers, water heaters, clothes washers, clothes dryers, ranges and ovens, dishwashers and television receivers.

The companies are Absocold Corporation, Acme National Refrigeration Company, Inc., Addison Products Company, Aeroneutronic Ford Corporation, Air Comfort Division of McGraw-Edison Company, Amana Refrigeration Inc., Blackstone Corporation, Boston Stove Company, Carrier Corporation, Duo-Therm Division of Motor Wheel Corporation, Eagle

Range and Manufacturing Company, Fedders Corporation, Frigidaire Division of General Motors Corporation, Gaffers and Sattler, Inc., subsidiary of Magic Chef, Inc., General Electric Company and GTE Sylvania, Inc.

Also included are Hardwick Stove Company, the Hoover Company, Keller-Columbus, Inc., Kitchenaid Division of Hobard Corporation, Magic Chef, Inc., Matsushita Electric Corporation of America, the Maytag Company, Phillips Industries, Inc., RCA Consumer Electronics, Rheem Manufacturing Company, Sage Laboratories, the Tappan Company, Thermador, Warwick Electronics, Inc., Waste-King Universal Division of Norris Industries, Whirlpool Corporation and Zenith Radio Corporation.

"By July 15 we hope to have at least 85 percent of appliance manufacturers, by sales, voluntarily participating in the program," Secretary Morton said. "The support of these 33 companies is an important step forward in achieving this goal." He pointed out that unless this goal can be reached voluntarily, the President will ask for legislation to make the energy efficiency program mandatory.

The 20 percent reduction in energy use for appliances is an average goal across all appliance types. Goals for specific appliance types may be higher or lower than the average depending on technical and economic feasibility. The base year from which improvements in energy efficiency are to be measured is 1972. Additionally, annual intermediate goals will be set and used to measure progress and report accomplishments.

In attaining the established goals each company will formulate its own plan which may include upgrading the entire line or a portion of the line,



eliminating less efficient models or modifying production mix.

The purpose of the meetings at NBS was to solicit comments and suggestions from the manufacturers as to how the program can be carried out. The Department of Commerce will publish in the *Federal Register* a proposed program to attain the energy efficiency goal for each appliance type to be reached by 1980, including any interim goals. There will be a 30 day comment period, with the final program published around June 30.

Overall responsibility for developing energy efficiency appliance goals has been assigned to the President's Energy Resources Council, of which Secretary of Commerce Morton is currently chairman.

Agencies participating in the Voluntary Program for Appliance Efficiency include the Department of Commerce, Federal Energy Administration and the Office of the Special Assistant to the President for Consumer Affairs. □

Hydrogen Fuel Topics Published

"SELECTED Topics of Hydrogen Fuel," a 216-page special publication prepared by the National Bureau of Standards' Cryogenics Division, Boulder, Colo., identifies cost and technical barriers involving the commercial use of hydrogen fuel and provides data bases necessary for objective policy planning, decision making and design.

Hydrogen fuel topics reviewed in this publication include: cost and availability; uses in the electrical utility and automobiles fuel industries; materials required for application and their properties; available instrumentation; transmission, solar energy and industrial applications; and a literature review.

Cost parameters have been applied to the publication's different topics and thus cost comparisons can be readily upgraded to reflect cost factors, by-product credits and technological advances.

Based on current economic data, cryogenic hydrogen fuel appears economically marginal in auto transportation and in electrical utility systems. The fuel appears attractive as an aircraft and aerospace fuel, a fuel to store solar energy and for transportation of energy from proposed solar sea power plants.

NBS has played a vital role in the development of hydrogen technology for the space age and is currently engaged in efforts to adapt and improve this cryogenic technology to commercial uses.

NBS Special Publication 419, "Selected Topics on Hydrogen Fuel," is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Order by SD Catalog No. C13.10:419 for \$2.80. □

Check Energy Labels on Room Air Conditioners

WITH hot weather only weeks away, it's time to start thinking about keeping cool. Consumers planning to buy a room air conditioner this summer can stay cool while saving energy—and money—by looking for Energy Guide Labels on the units.

The labels, developed by the National Bureau of Standards, are now appearing on nearly all room air conditioner units. The labels contain information on the energy efficiency of the individual room air conditioner and compare its efficiency with all similar capacity units in the marketplace.

The room air conditioner Energy Guide Label makes use of a concept known as the Energy Efficiency Ratio (EER). This is a number obtained by taking the air conditioner's cooling capacity (rated in Btu's per hour) and dividing it by the electricity demand (expressed in watts).

The EER is displayed prominently on the label which is glued or hung on the air conditioner unit. The higher the EER, the more efficient the unit and the less will be the cost of electricity to operate it.



The label also shows the range of EER's for all room air conditioners of similar size. By comparing the EER number with the range of numbers on the label, the consumer can determine how efficient with respect to energy use a model is compared to other models.

Labeling of room air conditioners is the first step in the Department of Commerce's Voluntary Energy Conservation Labeling Program for Household Appliances and Equipment that includes refrigerators, refrigerator-freezers, freezers, water heaters, dishwashers, clothes washers and dryers, kitchen ranges and ovens, and central heating and air conditioning equipment. The label specifications for all categories are developed by NBS in consultation with the Council of Environmental Quality and the Environmental Protection Agency.

Last year was the first in which room air conditioners were labeled, but not all room air conditioner manufacturers participated. This year 25 companies, responsible for producing about 95 percent of the units on the market, are labeling their room air conditioner units.

To assist consumers in choosing room air conditioners on the basis of cooling capacity and energy efficiency, NBS has published a pamphlet titled "Energy Efficiency in Room Air Conditioners." It describes what consumers need to know before buying a window or wall air conditioner. It answers questions on household wiring, cooling requirements of individual rooms, cost of electricity and the relationship of electricity cost to purchase price. Single copies of the pamphlet are available at no charge from the Consumer Product Information Center, Pueblo, Colo. 81009. □

METRIC *continued*

we in this country produce something like 1000 sizes of fan belts, in converting this could be cut by a factor of 10. Also, many of the industries that have converted have done so over a short time span, eliminating the need to work in both systems.

Another concern has to do with the overall approach to planning the national changeover. I think it is unrealistic for the proposed Board to produce in 12, or even 18, months an effective overall plan for national metrication over the ensuing 10 years. In the Administration's new proposal, planning, coordinating and problem solving would be a *continuing* process, tailored to the interests, needs and time requirements of the various sectors.

Need for Action

In 1968, Congress authorized an intensive 3-year metric study, which was conducted under the direction of the National Bureau of Standards. The study made a series of recommendations including:

- The United States should become predominately metric.
- This should be done through a coordinated program.
- Congress should assign the responsibility for guiding the change to a central coordinating body.
- Priority should be given to metric education.

If we follow these precepts, the Nation will benefit, and our children will not face continuing metric debate. We must ensure that the changes already underway will occur in the most efficient, least costly manner. The need for action is more urgent today than ever. □

MHD *continued*

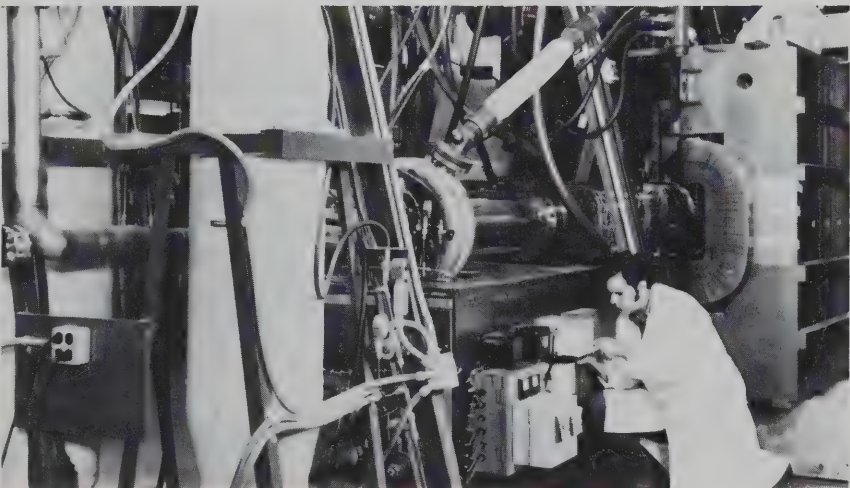
perature considerably and protected the electrode materials from apparent degradation.

Joint Test

Much additional information on materials behavior under actual MHD conditions will be gained later this summer when an electrode-insulator module built by Westinghouse Corp. under ERDA sponsorship is tested in the channel of the U-02 experimental MHD generator in the U.S.S.R. The module contains 20 samples of zirconia-based electrode materials selected by an ad hoc committee which included representatives from ERDA, NBS, MIT, Battelle Northwest and Westinghouse. The module will be tested for 100 hours under full MHD conditions with both American and Soviet scientists performing the experiment. Scientists from NBS and Battelle Northwest will characterize

samples of the materials before and after the test to see how well the materials stand up under actual MHD conditions.

If the many scientific and engineering problems associated with MHD can be solved within the next few years, many experts believe that MHD generating plants could be a major source of electricity by the end of the century. Indeed, so optimistic are some people that the problems can be solved that legislation has been introduced in Congress calling for the construction and operation of a 500 megawatt MHD demonstration plant by the mid-1980's. Whether this optimism is truly justified may become clearer as research carried out by ERDA, NBS, universities, private industry and other groups fill the gaps in knowledge about MHD systems and materials. □



Technician at Avco Corporation adjusts burner controls of MK VI MHD generator, one of several experimental MHD facilities being used in attempts to reach the goal of commercial MHD power generation.

Photo courtesy Avco Corporation.

COMPUTER *continued*

Computer AGAINST man.

In looking at these alternate future worlds, it will be helpful to think of the computer as a scientific artifact rather than simply as a glorified adding machine or calculator.

MAN WITHOUT COMPUTER is best dealt with by simply asking that we remember the world before 1945 and transplant it into today's time period. There are few of us who would care to ride on planes today if there were no computers in our air traffic control systems.

Waiting for credit to be approved or health insurance to be checked would be a tremendous time waster for most of us without the telephone or the computer.

There are, of course, many problems cited as due to the computer. Interestingly, and fortunately, however, recent polls have shown that most Americans properly attribute problems with computers to inadequacies in human management or to human error. These problems will disappear as we develop more expertise in computer science and technology.

MAN WITH COMPUTER and COMPUTER WITH MAN are two situations which must be dealt with separately because there is a subtle difference between them. Man *with* computer implies that man is "using" the computer; computer *with* man implies that the computer is in control and is "using" man. The difference is subtle scientifically, but it is not subtle in the real world.

Labor unions have the most difficulty in accepting changes when technology upsets the relative supremacy of man over machine. This is quite apparent in cases of automation where industrial robots

have been placed in assembly lines and workers have been relegated to such tasks as "oiling" the robots. Sabotage of automated assembly lines has been the recourse of laborers in several instances.

In the case of MAN WITH COMPUTER a few harbingers of the next 20 years that, with man coupled with computer, promise to bring us a better world will serve the point.

Most obvious are the extensive applications of computers and data links in banking, law enforcement, reservation systems, warehouse inventorying and libraries. The medical profession is also deep into these technologies in terms of computer storage of medical histories and computer diagnosis. Other evolving applications include the augmentation of man's intellectual efforts via computer manipulation of concepts and projection of man's manipulative capabilities into remote situations via teleoperators. For instance, the proposed undersea farms could be harvested and patrolled by teleoperator farmhands, controlled by sonar transmitters from the safety of surface ships.

By the end of the next two decades, these applications should be commonplace. Only unfounded prejudice and ill-conceived institutional barriers can prevent their happening.

The possibility of COMPUTERS WITHOUT MAN generally meets with annoyance or pious disbelief. But we already have limited instances of computer without man. For this situation is not synonymous with a world populated only by computers. Neither is it synonymous with computers as superior beings compared with man.

COMPUTERS WITHOUT MAN does

contemplate the carrying out of "intelligent" functions solely by computer-controlled devices with no intervention by man. And, indeed, this is a long overdue activity. There is no humane rationale that can any longer justify placing man in hazardous and dangerous environments when experiments indicate that the tasks being performed by men can be done by computers. Environments falling in this class include underground mining, space exploration, prison surveillance, city safety patrols, firefighting and military security.

There would appear to be nothing inherently wrong with man being able to develop "something" that could, in any instance, perform intelligent tasks better than man could. As Carl Sagan put it, the problem seems to be one of human chauvinism.

There are two ways in which the phenomenon of COMPUTERS AGAINST MAN can manifest itself. That is, in a one-on-one manner, where one computer is against one man or institutions with computers against institutions without computers.

The latter instance is the more common. We see it with banks having computers competing with banks without computers; with scientific laboratories with computers competing with laboratories without computers; with airlines having computerized reservation systems competing with airlines not having them. It is rare that the computer owners do not "win" these competitions. It will be even more rare in the future.

The "one-on-one" situation is found in cases of computerized individual instruction compared with manual instruction; with a doctor

who employs computer-aided diagnosis compared with one who does not.

What, then, can be said in summary about the next 20 years in terms of computers and individuals?

Progress—or change—in the advanced, imaginative uses of computer will be despairingly slow, much slower, in fact, than in the last 20 years of computer innovations. This will be due to such problems as public reaction to further change in this field, lack of encouragement of scientific imagination in this area, continuing misunderstanding of the present and potential gains possible through computer science, and non-imaginative exploitation of this academic area by universities.

Imaginative advances will “go underground” rather than be subjected to the constraints imposed by public ignorance and institutional controls which bar change.

Decreasing costs and decreasing size of computers and logical devices will put these scientific artifacts into the hands of large numbers of individuals. We will see spurts of that “basement creativity” for which Americans are so renowned. Computer-related advances will be many, random and beneficial, although localized without large-scale diffusion.

Man coupled *with* computers will outlast man *without* computers, both individually and in groups.

Man is increasing the number of “intelligent” tasks for computers faster than he is increasing them for himself.

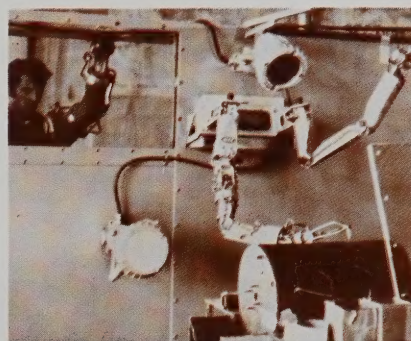
Computers will provide to the individual more control over his personal environment than he has ever before been able to exercise. This

capability will result from the miniaturization of computer components along with the decreased cost of computer hardware.

Major government efforts will be directed toward the use of computers in response to demands for increasing public accountability. This will take the form of more computers used for more record-keeping tasks.

A great deal of managerial and scientific talent will be spent on defensive efforts to counter resistance to computer use in public service and safety functions.

The next 5 to 7 years will see a continuation of the current trend to isolate the scientist from the computer by a maze of operating systems and programming language barriers. This will perpetuate for a time the continuing diminution of advances in computer science and imaginative computer applications.



One example of Man with Computer is found in the development of remotely controlled mobile systems for disarming faulty shells and other explosive devices.

In spite of all man-made constraints, there will be an irreversible but slow trek to realize with computers forms of intelligent behavior that are essentially limitless—transcending man and computer taken separately.

The concern of today is that people may become the victims rather than the masters of technology. To escape such a fate, we must decide what we wish for ourselves and apply technology to achieve our goals. But, few people excel at changing fantasy into fact.

What is needed is to tackle the really impossible and take the working environment of today, the worker of today, the technologies we understand and try to effect a change into a more desirable working environment in the next 20 years. A more productive and happier citizen and a more comfortable society will result. □



Computer-controlled robot manipulators can carry out high dexterity operations that are hazardous, tedious or otherwise unsatisfactory for people to do directly.

FIRE *continued*

more soundly than adults, and they don't know how to react. Old age often impairs the ability to escape quickly," Halpin noted.

"Furthermore," he said, "people in these age groups are more likely to be at home than teenagers or adults in their twenties and thirties." Halpin also pointed out that pre-existing heart disease combined with toxic gases often causes death in older persons caught in a fire.

Preventing Future Fatalities

Looking at the conclusions reached to date by this study, what can be done to prevent fire fatalities? There are a number of possible approaches to examine: building structure, toxicity and flammability of materials found in the home, safety of home appliances, detection and warning systems and human reactions. A lot of research has been done in some of these areas, but the others have remained untouched until recently.

"In our study," said Halpin, "one of the major things we're trying to investigate is the time lapse between discovering a fire and getting out. We want to know how we can buy time. We need detection devices and alarms that can detect a fire and wake you out of your sleep even if you're sleeping very soundly."

Since safe escape in part depends on how people react to fire, Halpin believes that mass education can help. "I'm a firm believer in safety education, including fire safety, in the schools," he said. "Not just once a year during fire prevention week, but regularly. It has to be done in school because children are a captive audience there."

Fire drills in the home are also important, Halpin noted. Parents often teach their children not to play with

matches, but do they teach young children how to recognize fire, how to seek immediate help, and how to escape if a fire occurs? Every family should practice home fire drills, Halpin said.

What about decreasing the dangers of combustion? "Most fire victims who aren't burned by flames are overcome by carbon monoxide, and trying to eliminate this problem would be almost impossible," said Halpin.

Some efforts to reduce flammability of commonly used materials, especially of highly flammable plastics and polymers, may have created problems with toxicity. "Many of the new flame-retardant materials are slower to ignite, but when they do catch fire, they may give off fumes that are more lethal than carbon monoxide."

"There's a controversy as to whether materials can be made both non-flammable and non-toxic," Halpin noted.

Related Studies

In an NBS-funded study at the University of Utah, scientists exposed rats to fire fumes from a particular polyurethane foam that had been treated with a common phosphate fire retardant. Polyurethane foam is a material commonly used in mattresses and other furniture. While rats exposed to fumes from the non-treated foam were about to "escape" from a plate-sized circle in less than 6 seconds, rats exposed to the smoke from this particular flame-retarded foam became so disoriented that they could not escape in less than a minute; some could not escape at all.

Furthermore, 20 minutes after exposure the rats could not perform normal movements correctly. Within



an hour they developed epileptic-like seizures, and depending on the concentration of flame retardant in the foam, some later developed major seizures and died.

Rats exposed to combustion products from other fire retardant polyurethane foams did not show these effects, however. NBS scientists say that the toxicity problem is highly complex, and that further research is needed before the problem can be fully understood.

Studies such as the University of Utah project will eventually form the basis of new toxicity as well as flammability standards for materials; meanwhile, the Maryland research will provide new information on why people die in fires and how human reactions and behaviors contribute to fire fatalities. Both types of studies involve unique and novel approaches and procedures. The information that they offer to date raises some hopeful possibilities of reducing fire deaths through the application of new knowledge. □

of the National Bureau of Standards

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